Douglas Partners
Geotechnics / Environment / Groundwater

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Report on
Phase 1 Contamination Assessment

Campbelltown Hospital Redevelopment
Therry Road, Campbelltown

Prepared for
Health Infrastructure – NSW Health

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
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Reviewer	 for PG	13 May 2011

NCS INTERNATIONAL CERTIFIED QUALITY MANAGEMENT SYSTEM

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit 5, 50 Topham Road
Smeaton Grange NSW 2567
Phone (02) 4647 0075
Fax (02) 4646 1886

Executive Summary

This report presents the results of a Phase 1 Contamination Assessment undertaken at Campbelltown Hospital, Therry Road, Campbelltown. The aim of this assessment was to provide preliminary information on the contamination status for the proposed development of Campbelltown Hospital. The investigation is required for due-diligence purposes.

The proposed development includes the construction of a new clinical services building of up to 6 storeys, a two level mental health building, associated on grade car parking and relocation of the helipad. This assessment has been conducted in the areas of the proposed development as shown on Drawing 1, Appendix A.

This assessment comprised a site history review, a site inspection, review of subsurface information obtained during the geotechnical investigation and reporting.

The site history investigation indicated that the site was vacant in 1947, with the development of the hospital commencing in about 1975. The Site has continued to be used as a hospital since, with additions and accommodation being constructed through its operation period. WorkCover NSW records show that a number of diesel underground storage tanks (UST) were installed and abandoned in the Hospital grounds. The current records indicate that there is a 10 000 L UST located near the cancer therapy building and the helipad, a 5 000 L UST located near the accidents and emergency entrance to the hospital, and two liquid Oxygen tanks (1 500 L and 15 000 L) also located near the accidents and emergency entrance. The location of an abandoned UST is shown approximately on Drawing 2, attached. Records indicate that the tank was decommissioned and filled with a slurry mixture in February 2001.

A total of 41 bores were drilled across the Site (BH1 to BH41) to varying depths as part of the geotechnical investigation. Fill was observed in 27 of the 41 bores, to a maximum penetrated depth of 4.9 m and anthropogenic materials were encountered in 10 of the bores, comprising concrete rubble, steel, crushed igneous and sandstone gravel (road base), and brick fragments.

Based on the site history and site observations, it is considered that the Site has a moderate risk of contamination being present. Identified areas of environmental concern (AEC) include the USTs, imported filling, building material demolition or degradation, incineration and engineering and maintenance workshops.

Given the potential for contamination, we recommend the implementation of a Phase 2 Contamination Assessment, including intrusive sampling of soil and groundwater, targeting the areas of environmental concern. Should the Phase 2 Assessment identify unaccetable contaminant levels, remediation will then be required to be implemented and validated in accordance with a Remediation Action Plan (RAP).

In terms of the hospital grounds in general, it should be noted that the *NSW DECCW Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* requires owners of UPSS to have in place a leak detection system, an environment management plan and a groundwater monitoring system.

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Report on Phase 1 Contamination Assessment
Proposed Campbelltown Hospital Redevelopment
Therry Road, Campbelltown

1. Introduction

This report presents the results of a Phase 1 Contamination Assessment undertaken at Campbelltown Hospital, Therry Road, Campbelltown. The investigation was commissioned on the basis of the Health Infrastructure agreement (Contract No. HI11042) dated 4 March 2011 and was undertaken in accordance with Douglas Partners (DP)' proposal dated 7 February 2011.

The aim of this assessment was to provide preliminary information on the contamination status of the site in areas of proposed development within the Campbelltown Hospital. The investigation is required for due-diligence purposes.

This assessment has been conducted in the areas of the proposed development, as shown in Drawing 1, Appendix A. The total of the areas of proposed works is approximately 3.5 ha and is referred to collectively herein as "the Site".

This assessment comprised a site history review and site inspection, as well as limited drilling, soil sampling, laboratory analysis in the area which corresponds to the geotechnical investigation, and interpretation of results with reference to current NSW Office of Environment and Heritage (OEH) produced or endorsed guidelines.

This assessment was undertaken concurrently with a geotechnical investigation at the site (Project 34275.00), which is reported separately. Test pit logs produced for the geotechnical investigation were reviewed in this contamination assessment.

2. Scope of Works

The Phase 1 Contamination Assessment included the following scope of works:

- A site history investigation including a review of:
  - NSW OEH public registers under the *Contaminated Land Management Act 1997* and the *Protection of the Environment Operations Act 1997*;
  - historical aerial photography obtained through the Land Information Section of the Department of Planning;
  - previous site ownership through historic title deeds obtained from the Land Titles Office;
  - readily accessible Council Records and the Section 149 certificate;
  - WorkCover search for dangerous good and underground petroleum storage systems (UPSS) at the site; and

  - o interviews with any person(s) identified by the client as having knowledge of the site conditions and previous site use.
- Review of additional site information including geology and hydrogeology.
- Review of subsurface information at the site obtained through DP bore logs.
- Inspection of the site to identify any signs of contamination concern.
- Preparation of this Phase 1 Contamination Assessment report detailing the methodology and results of the assessment, commenting on contamination issues and making recommendations for further works.

3. Site Information

3.1 Site Identification

The Site is located within Campbelltown Hospital and is identified as part Lot 6 in DP1058047 within the local government area of Campbelltown City Council. This assessment has been conducted in the areas of the proposed development, as shown on Drawing 1, Appendix A.

3.2 Site Description

There are various zones within the Site, which include the following:

- The northern proposed carpark which is currently occupied by both paved and un-paved carparks, lawn areas, landscaping and internal hospital roads;
- The proposed clinical services building in the western portion of the hospital grounds, which is currently occupied by a helipad;
- The proposed temporary helipad location in the west of the hospital grounds, which is currently occupied by lawn areas;
- The proposed Mental Health Services Building in the eastern portion of the hospital grounds, which is currently occupied by the engineering building, the entrance and small portion of a current carpark area, four small sheds, and lawn and landscaping areas; and
- The proposed car park in the south, which is currently occupied by a paved asphalt car park along with grassed surfaces.

Within the remaining areas of the Campbelltown hospital boundary there are two USTs, one above ground storage tank, numerous hospital associated buildings and carparks.

Reference should be made to Drawings 1 and 2, Appendix A, for the locations of the features mentioned above.

3.3 Surrounding Landuse

The surrounding land uses include the remaining portions of Campbelltown Hospital and also the following:

- North: Medium density retirement housing;
- East: Appin Road followed by residential housing in Bradbury;
- South: Therry Road followed by residential housing in the suburb of Ambarvale;
- West: Recreational parkland with urban storm water management lakes and water features, followed by residential housing,

3.4 Proposed Development

The proposed development includes the construction of a new clinical services building of up to 6 storeys, a two level mental health services building, associated on grade car parking and temporary relocation of the helipad.

4. Regional Geology and Hydrogeology

Reference to the 1:100 000 Wollongong – Port Hacking Geological Series Sheet indicates that the site is underlain by Ashfield Shale of the Wianamatta group of Triassic age. This formation typically comprises of laminite and dark grey siltstone.

A registered groundwater bore search was conducted on the NSW groundwater works website set up by the Department of Industry and Investment (DII, formerly Department of Natural Resources) on 21 February, 2011. A review of licensed bores in the surrounding area of a site can indicate regional water quality, lithology and depth to groundwater and groundwater uses within the area. Four groundwater bores were identified, three to the west and one to the east of the site. These were registered as monitoring bores. Groundwater was noted in all bores in the west at a depth of about 6 m below ground level.

5. Site History Investigation

The site history investigation was conducted over the larger Campbelltown Hospital, refer Drawing 1, Appendix A.

5.1 Historical Aerial Photograph

Historical aerial photographs from six periods of photography, archived by the Land Information Section of the Department of Lands, were inspected and are included in Appendix A (Drawings 3 – 8). Aerial photographs reviewed included:

- 16 Jan 1947;
- 1961;
- 30 November 1975;
- 8 October 1984;
- 4 January 1994; and
- September 2010.

Photographs were reviewed for signs of potential concern, such as structures which may have since been demolished, ground disturbance, bulk excavation, areas of filling and evidence of stockpiling. Unexplained surface features were noted. A summary of each review is given.

16 January 1947
The Site was undeveloped and was cleared grazing land which was divided into numerous paddocks. There was a creek running through the northern half of the site to a large portion of disturbed land in the south. Appin Road borders the site to the east.

1961
The Site remained cleared, with the creek in the north running to disturbed land in the south. There were five houses that had been constructed since the previous photograph along Appin Road. There were a number of large U shaped mounds (possible dams) present in the north-eastern portion of the Site, with changed ground conditions down gradient towards the creek.

30 November 1975
The Site had significantly changed since the previous photograph, with large ground disturbances and construction of parts of the current hospital in the central portion of the site. Residential development had been completed to the east, with a large number of residential houses being constructed since the previous photograph. Roads had been constructed to the south of the site. The mounds observed in the north-eastern portion of the previous photograph can be seen again, it is clearly visible that there were four U shaped mounds.

8 October 1984
The Site was now an established hospital with associated car parks and roads on site. There were buildings being constructed in the northern portion of the site. Appin Road had been realigned since the previous photograph and Therry Road had been constructed. Development of Ambarvale had begun to the south of the Site. The buildings being constructed in the northern portion of the site had been constructed over two of the U shaped mounds seen in the previous photographs in the north-eastern corner, with two mounds remaining. An area of filling can be seen north of the construction area. Only minor remnants of the creek in the north now remain, suggesting that the creek had been partially infilled.

4 January 1994
The construction previously seen in the northern portion of the Site had been completed. There was also the addition of a car park in the north-east. There is virtually no sign of the creek previously observed in the north of the site. The surrounding area appears to be unchanged.

17 September 2010
The Site had been developed significantly since the previous photograph, with additional buildings and car parks being developed over the site. The south of the site remained cleared grassed land. The Macarthur Gardens estate had been developed around the north and north-west of the Site.

5.2 Review of Planning Certificate under Section 149

The planning certificate under Section 149 (2 and 5) of the *Environmental Planning and Assessment Act*, 1979 was issued by Campbelltown City Council on 28 February, 2011, was reviewed.

The Certificate stated that under Section 59(2) of the *Contaminated Land Management Act* 1997, the site is:

- not significantly contaminated land;
- not subject to a management order;
- not the subject of an approved voluntary management proposal;
- not subject to an ongoing maintenance order; and
- not the subject of a site audit statement.

5.3 NSW OEH Search

A search under the Contaminated Land Register completed on 21 February 2011 showed that no regulatory Notices have been issued for the site under the *Contaminated Land Management Act*.

A search under the Public Register completed on 21 February 2011 showed that a licence had been issued for the site under the *Protection of the Environment Operations Act*. This licence is summarised below.

- Licence number 7457- Hazardous, industrial or Group A waste Generation or storage.

5.4 Review of WorkCover Licensing

The results for a WorkCover search for licences to keep dangerous goods at the entire Campbelltown Hospital site were received on 16 March 2011. A copy of the WorkCover search documents is provided in Appendix B and summarised below. It is noted that the sketches showing the location of the dangerous goods stores were generally not to scale and of limited detail.

- In 1984 an inspection was recorded, the inspection was for:
  - the removal of existing 1200 L liquid oxygen VIV and emergency supply located near an access road approximately 60 m from the engineering services building;
  - and the installation of a new 5000 L liquid Oxygen VIV and emergency supply cylinders 30 m across an access roadway from the engineering services building.
- In 1996 and 1997 an application for renewal was submitted by Campbelltown Health Service, and included the following dangerous goods;
  - Roofed stored products such as:
    - Aerosols 1000 L;
    - Methylated Spirit 50 L;
    - Hexanols 10 L;
    - Diesel 400 L;
  - Above Ground Stored Goods;
    - Refrigerated Oxygen 7000 L;
  - Flammable liquids cabinet;
    - Petrol 100 L.
- In 2001, a 5000 L UST near Stage 2 and within Stage 3 of the hospital, was filled with a slurry mixture and certified in the documents provided in Appendix B. There was also the installation of one new underground 5000 L diesel tank near the accidents and emergency entrance to the hospital. A 500 L above ground diesel tank was shown to be located between the print shop and the maintenance building, and a 7000 L liquid oxygen tank is shown near the new 5000 L underground diesel tank.
- In 2002, the dangerous goods licence requirements were reviewed and it was found that the Site was not required to have licences for 1 x 500 L above ground diesel tank, 7000 L liquid oxygen tank and 2 x underground 5000 L diesel tanks.
- In 2009 a notification of dangerous goods on premises form, was completed and displayed that there were now 1 x 10 000 L diesel underground storage tank, 1 x 5000 L underground storage tank, 1 x 1500 L liquid oxygen tank and 1 x 15 000 L Liquid Oxygen tank located within the Site (refer Drawing 2, Appendix B for approximate locations).

5.5 Title Deeds Search

A title deed search was conducted by Service First Registration Pty Ltd, Legal Agents. The title information can assist in the identification of previous land uses through the recorded occupation of individual land owners or by a descriptive company name. This may, therefore, establish potentially contaminating activities. The Campbelltown Hospital site was divided into three portions and a summary of the results of the site history and title deeds search are shown in the following tables. The site was divided into three portions and is identified by different colouring as shown in the full results of the search given in Appendix C.

Table 1: Results of Title Deeds Search for Yellow Highlighted Area Lot 6 in DP 1058047

Date of Acquisition	Owner and Occupation	Inferred Land use
24.10.1907	Perpetual Trustee Company Limited	Vacant
04.05.1925	Samuel James Allen (Grazier)	Rural / Farming
28.05.1925	Clarence Alwyn Ducat (Farmer) Sarah Maude Ducat (Married Woman)	Rural / Farming
17.03.1961	King Dairy Pty Limited	Farming
07.04.1968	State Planning Authority of New South Wales (Then New South Wales Planning and Environment Commission)	
22.12.1981	# Health Commission of New South Wales (# Now Health Administration Corporation)	Hospital

# Denotes current registered proprietor

Table 2: Results of Title Deeds Search for Pink Highlighted Area Lot 6 in DP 1058047

Date of Acquisition	Owner and Occupation	Inferred Land use
27.11.1914	George Joseph Spearing (Freeholder)	Rural / Farming
28.03.1934	Walter Allen Spearing (Newsagent) William Farrow (Retired Engineer) (Transmission Application not investigated)	Rural / Farming
10.12.1934	Frederick William George Spearing (Clerk) Walter Allen Spearing (Newsagent)	Rural / Farming
28.08.1950	Walter Allen Spearing (Retired Newsagent)	Rural / Farming
21.04.1953	Donald MacDonald (Butcher)	Rural / Farming
25.02.1955	The Council of the Municipality of Campbelltown	Rural / Farming
21.08.1956	Clarence Alwyn Ducat (Farmer) Sarah Maude Ducat (Married Woman)	Rural / Farming
30.06.1980	New South Wales Planning and Environment Commission (Now Minister Administering the Environmental Planning and Assessment Act,1979)	
16.11.1987	# Health Administration Corporation	Hospital

# Denotes current registered proprietor

Table 3: Results of Title Deeds Search for the Hatched Red Area Lot 6 in DP 1058047

Date of Acquisition	Owner and Occupation	Inferred Land use
27.11.1914	George Joseph Spearing (Freeholder)	Rural / Farming
28.03.1934	Walter Allen Spearing (Newsagent) William Farrow (Retired Engineer) (Transmission Application not investigated)	Rural / Farming
10.12.1934	Frederick William George Spearing (Clerk) Walter Allen Spearing (Newsagent)	Rural / Farming
28.08.1950	Walter Allen Spearing (Retired Newsagent)	Rural / Farming
21.04.1953	Donald MacDonald (Butcher)	Rural / Farming
25.02.1955	The Council of the Municipality of Campbelltown	Rural / Farming
21.08.1956	Clarence Alwyn Ducat (Farmer) Sarah Maude Ducat (Married Woman)	Rural / Farming
30.06.1980	New South Wales Planning and Environment Commission (Now Minister Administering the Environmental Planning and Assessment Act,1979)	
21.05.1985	Director, Macarthur Growth Area (Now Landcom)	
15.10.2003	# Health Administration Corporation	Hospital

# Denotes current registered proprietor

In establishing the possible use of the site, information has also been drawn from other sources, such as aerial photographs and council records.

5.6 Review of Council Records

A review of council records was conducted on the 22 March 2011 and the following development applications and Building Consents were available for review:

- 23 April 1975 the building consent was approved for two stages of Campbelltown Hospital which included:
  - Two buildings with one building being 2 storey and a 4 storey tower and the other being 3 storey.
  - A total floor area of 15 000 m^2.
  - 600 parking spaces.
  - 1200 employees.

- 29 April 1980 an Ambulance Station was approved.
- 27 February 1991 a Development Application was approved for the first stage of 8 residential accommodation units associated with the hospital.
- 6 June 1996 a Development Application was submitted for alterations and additions to the inpatient mental health unit at Campbelltown Hospital.
- 10 April 1996 a Building permit was granted for a contaminated waste compound awning to be constructed.
- 8 October 1998, an application was lodged for extensions and alterations to the existing staff car park.
- 17 June 1999 an application for the alterations and additions to Campbelltown Hospital was approved, which included the addition of a cancer therapy facility and ten (10) bed child and adolescent inpatient unit, adjacent to the adult mental health facility.
- 18 April 2001 an application of additions to 'Coopers Cottage' was approved.

5.7 Interview with Site Personnel

An interview was conducted with Mr Ronald Fullwood of Campbelltown Hospital with respect to the Campbelltown Hospital site. The interview confirmed the Site history searches and in particular the WorkCover Search. The interview confirmed that there were:

- Two UST's located within Campbelltown Hospital with a capacity of 10 000 L and 5000 L.
- One above ground storage tank is located adjacent to the engineering building with a capacity of 500 L of diesel.
- No reported spills were known to have occurred.

6. Site Inspection

A site inspection was undertaken by a geo-environmental engineer from DP on 22 February 2011. During the inspection the following were noted:

- The site is used as a hospital with associated car parks for both staff and visitors. The carparks extend to much of the north-west of the site on both gravelled and asphalt surfaces.
- Internal hospital roads are located within the Site.
- No waste stockpiles were observed within the Site.
- The hospital buildings appeared to be well maintained and show no significant signs of damage, although no up close inspection was conducted.
- The helipad area appeared to be levelled with filling.
- No visual signs of staining on the ground surface, litter, or chemical containers which could cause contamination, were observed.

6.1 Observations made from Geotechnical Investigation

A geotechnical investigation was undertaken, and as part of the intrusive investigation there were a total of 41 bore holes (BH) drilled across the Site (BH1 to BH41) to varying depths. Some of the bores were positioned outside the Site areas, as the bore locations were specified in the geotechnical brief.

Although environmental samples were not collected, observations were made during excavation to confirm the presence or absence of potential filling across the Site.

Fill was observed in 27 of the 41 boreholes to depths of up to 4.9 m with BH6, BH32, BH33 and BH39 refusing within filling. Anthropogenic materials was encountered in ten of the bore holes, comprising:

- BH2, located within the proposed AHS building area. Fill comprised brown grey silty fine to coarse grained siltstone gravel with trace concrete fragments and fine to coarse grained sand to a depth of 3.6 m;
- BH4, located in the proposed AHS building area. Fill comprised brown silty fine to coarse grained sandy, fine to coarse grained igneous gravel filling to a depth of 0.4 m, underlain by brown fine to coarse grained igneous and siltstone gravelly clay filling with trace steel, brick and concrete fragments to a depth of 3.8 m;
- BH7, located within the proposed mental health services building. The fill was underlying asphalt (30 mm thick) and comprised dark brown grey silty fine to coarse grained sandy fine to medium grained igneous gravel (road base) filling to a depth of 0.3 m, underlain by brown silty fine to coarse grained sandy fine to medium grained sandstone gravel filling to a depth of 0.6 m and then underlain by natural silty clay;
- BH8, located within the proposed mental health services building. The fill was underlying asphalt (30 mm thick) and comprised light grey silty fine to coarse grained sandy fine to medium grained igneous gravel (crushed concrete) filling to a depth of 0.3 m, underlain by natural silty clay;
- BH21, located within the proposed southern carpark. The fill was underlying asphalt (30 mm thick) and comprised light brown silty fine to coarse grained sandy fine to coarse grained sandstone gravel (crushed sandstone) filling to a depth of 0.4 m, underlain by natural silty clay;
- BH27, located within the proposed northern carpark. Fill comprised brown silty fine to coarse grained igneous gravel with concrete and brick fragments to a depth of 0.05 m, underlain by natural silt;
- BH28, located within the proposed northern carpark. Fill comprised brown silty, fine to coarse grained sandy, fine to coarse grained igneous gravel (road base) filling with some concrete fragments to a depth of 0.4 m, underlain by natural silty clay;
- BH29, located within the proposed northern carpark. Fill comprised brown silty, fine to coarse grained sandy, fine to coarse grained igneous gravel (road base) filling with some concrete fragments to a depth of 0.2 m, underlain by brown silty fine to coarse grained shale gravel filling with some fine to coarse grained sand to a depth of 1.1 m, underlain by natural silty clay;
- BH32, located within the proposed northern carpark area. Fill comprised brown silty, fine to coarse grained sandy, fine to coarse grained igneous and shale gravel with some concrete, brick and steel fragments with refusal in filling at 1.9 m; and

- BH38, located within the proposed northern carpark. The fill was underlying asphalt (30 mm thick) and comprised green grey silty, fine to coarse grained sandy, fine to coarse grained igneous gravel (road base) filling to a depth of 0.1 m, underlain by light brown silty fine to coarse grained sandy, fine to course grained sandstone gravel (crushed sandstone) filling followed by natural shaly clay.

Anthropogenic material was not observed in any other bore hole where fill was encountered. The fill in other locations generally comprised clayey/silty, fine to coarse grained sandy, fine to course grained shale/siltstone or igneous gravel (road base).

No staining or odours were encountered in any of the borehole locations.

No free groundwater was observed in the bore holes during auguring or for the short time that they were left open. The introduction of water into the bore during the rotary coring and the immediate backfilling of the bores precluded any further monitoring of any groundwater levels that might be present.

Borehole locations are shown in Drawing 1, Appendix A, and bore logs are provided in Appendix D. The bore logs include details of the subsurface conditions encountered and notes defining classification methods and descriptive terms.

7. Contamination Issues

7.1 Areas of Environmental Concern (AEC)

From the site history review, potential areas of environmental concern (AEC) have been identified and are discussed below.

Underground Storage Tanks (UST)
Although the identified USTs (Drawing 2) are not within the proposed development boundaries defined for this investigation, the USTs may still have potentially contaminating effects on the areas, due to fuel leaks or spills from the USTs or associated bowsers and subsequent migration.

Filling
There is significant filling located within the proposed northern carpark area, the proposed clinical services building and proposed helipad to depths of up to 4.9 m, however some bores refused within filling. Some portions of this filling contained anthropogenic material, such as concrete rubble and steel. The fill is likely to have been imported and the source is unknown.

Demolition and Degradation of Structures
Demolition and degradation of structures with asbestos-containing materials, and/or lead based paints, may potentially be an issue with the amount of building and structures present within the Campbelltown Hospital site. (Note that site history suggests that previous demolition of structures at the site is unlikely to be extensive).

Incinerators and Boilers
Hospitals often contain areas of waste incineration and boilers which present sources of potential contamination. It is not known if these exist, or existed in the past, within the proposed development areas.

Engineering and Maintenance Workshops
Engineering workshops and maintenance sheds are localised sources of potential contamination predominantly assocated with hydrocarbons (eg: oils and fuels).

7.2 Potential Contaminants of Concern

Based on the abovementioned AEC, the main potential contaminants of concern (PCOC) are expected to be total petroleum hydrocarbons (TPH), benzene, toluene, ethyl benzene and xylenes (BTEX), polycylic aromatic hydrocarbons (PAH), volatile organic compounds (VOC), asbestos and heavy metals. Other common contaminants which may be present include phenols, organochlorine pesticides (OCP) and polychlorinated biphenyls (PCB). Dioxins are a potential contaminant known to be associated with uncontrolled incineration of hospital waste.

8. Conclusion and Recommendations

Based on the site history and site observations, it is considered that the Site has a moderate risk of contamination being present, with the identified AEC and PCOC listed in Section 7. Given the potential for contamination, we recommend the implementation of a Phase 2 Contamination Assessment, including intrusive sampling of soil and groundwater, targeting the areas of environmental concern. Should the Phase 2 Assessment identify unaccetable contaminant levels, remediation will then be required to be implemented and validated in accordance with a Remediation Action Plan (RAP).

In terms of the hospital grounds in general, it should be noted that the *NSW DECCW Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* requires owners of UPSS to have in place a leak detection system, an environment management plan and a groundwater monitoring system.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for a project at Campbelltown Hospital, Therry Road, Campbelltown, NSW in accordance with DP's proposal dated 7 February 2011. The report is provided for the exclusive use of Health Infrastructure – NSW Health for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

About this Report
Drawings
Historic Aerial Photographs

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

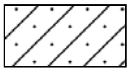
Soils


Topsoil

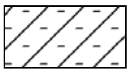

Peat


Clay

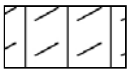

Silty clay

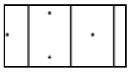

Sandy clay

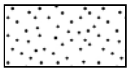

Gravelly clay

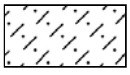

Shaly clay

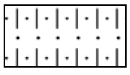

Silt


Clayey silt


Sandy silt

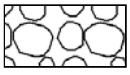

Sand

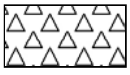

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

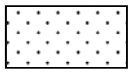

Talus

Sedimentary Rocks

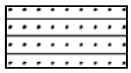

Boulder conglomerate

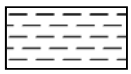

Conglomerate


Conglomeratic sandstone

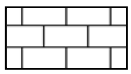

Sandstone


Siltstone


Laminite

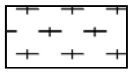

Mudstone, claystone, shale

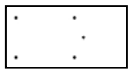

Coal


Limestone

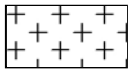
Metamorphic Rocks

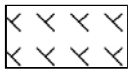

Slate, phyllite, schist

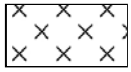

Gneiss

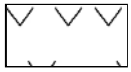

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m